

0.6
THESIS/
REPORTS

DANA, S.T.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN FOREST EXPERIMENT STATION
AMHERST, MASSACHUSETTS



Report on European Forest Experiment Stations

Visited Between May 12 and June 30, 1926

By Samuel T. Dana, Director

REPORT ON
EUROPEAN FOREST EXPERIMENT STATIONS

Visited Between May 12 and June 30, 1926

By Samuel T. Dana,
Director, Northeastern Forest Experiment Station.

ITALY

The Italian Forest Experiment Station (Stazione Sperimentale di Selvicoltura) commenced its activities in April, 1922, with the director as the sole member of the staff. An assistant was added in 1924 so that the staff now consists of -

Prof. Aldo Pavari, Director

Dr. Giuseppe Cristofani, Assistant.

The station is theoretically a part of the School of Agriculture and Forestry (R. Istituto Superiore Agrario e Forestale) at Florence, of which Gr. Uff. Prof. A. Serpieri is dean. The school in turn comes under the Ministry of National Economy, which includes all federal activities dealing with agriculture, forests, and public lands. (Gr. Uff. Dott. Alessandro Stella is the Director General of Forests and Lands.) The investigative work is, however, entirely divorced from teaching, and in actual practice the Station enjoys a large measure of independence.

Because of its limited resources the Forest Experiment Station devotes its attention almost wholly to the planning and direction of experiments rather than to their actual conduct. Recognizing the fact that two men alone would be able to accomplish but little in the way of field studies, the Station has tried to secure results by

enlisting the services of federal forest officers throughout the country.

The men at the Station decide what studies should be undertaken, prepare working plans for them, obtain such special material as may be needed, as for example seed for reforestation experiments, and make more or less frequent field inspections of the progress of the work. The actual laying out of sample plots and the taking both of original and subsequent measurements are, however, handled almost entirely by the regular administrative force. All records are sent for filing and analysis to the Experiment Station, which is responsible for the drawing of conclusions, the preparation of reports, and the publication of results.

The director of the Station states that this procedure works well. He says that the forest officers called upon for assistance generally take a real interest in the work, have sufficient time to devote to it, and submit satisfactory records. The Italian Station is, however, the only one of those visited where this system is now used. Elsewhere administrative men are encouraged to undertake investigations of local interest on their own initiative, but no attempt is made to enlist their regular assistance in the execution of the Experiment Station's program. Experience has shown that in the long run investigative work can be handled most effectively by men with special training who are able to devote their entire time to it; and that this is increasingly true as the work becomes more intensive.

The activities of the Italian Forest Experiment Station are still pretty much in the formative stage. So far particular

emphasis has been laid on reforestation, with special reference to exotics. Small local nurseries have been established in different parts of the country at which a large number of species, mainly conifers, are being tried out. Considerable attention has also been paid to fertilizer experiments. By the end of 1925, 150 permanent sample plots dealing with reforestation problems had been established with a total area of about 150 acres.

No fundamental investigations dealing with the measurement of physical factors have yet been undertaken, partly because of lack of resources and partly because of the belief that for the present attention should be centered on some of the many urgent practical problems which are crying for solution. Work of this character is, however, contemplated in time. Tentative plans have also been made for the establishment of about three sub-stations. The work of the station will gradually be concentrated at these so far as practicable, but it is anticipated that a large number of experiments will always have to be conducted throughout the country in order to give full consideration to local conditions.

Some investigative work, particularly in forest products, is done by professors at the Forest School. Otherwise there seems to be little research activity outside of the Experiment Station.

On the whole it seems doubtful whether there is much that the United States can learn from Italy in the field of forest research at this time.

AUSTRIA

The Austrian Forest Experiment Station (Forstliche Bundes-Versuchsanstalt) is at Mariabrunn, a few miles from Vienna. It was established in 1875, and is thus one of the oldest in Europe. Prior to the war it had a permanent staff of eight technical men with twelve assistants. This has now been reduced to four technical men and four assistants. The former, with the subjects in which each is specializing, are as follows:

Hofrat Ing. Dr. Phil. Walter Sedlaczek, Director, - forest protection, with special reference to forest entomology.

Regierungsrat Dr. Peter Rumov, - forest chemistry, soil science, meteorology.

Regierungsrat Ing. Dr. Leo Tschernak, --- silvics and silviculture.

Oberinspektor Ing. Dr. Herbert Schmied, - forest mensuration, phytopathology, and botany.

Administratively the Experiment Station comes under the Bureau of Forestry (Bundesministerium für Land- und Forstwirtschaft), of which Ministerialrat Anton Locker is in charge, and which in turn is part of the Ministry of Agriculture. Its primary duty is to see that the laws concerning the management of both private and public forests are adequately enforced. The actual administration of the State forests is handled by a recently created corporation known as the "Österreichische Bundesforste", (under General Direktor Löv,) which is also in the Ministry of Agriculture but is entirely independent of the Bureau of Forestry.

The experiment station has to submit an annual program of work and an annual report, which are approved by the Minister of Agriculture. This approval is rather perfunctory, however, and there is no

inspection of the station's activities. Practically therefore it is virtually independent to do as it pleases within the limits allowed by its budget.

The director of the Station is not appointed for a limited period, as is the case at many of the European forest experiment stations, and exercises real supervision over the activities of the other members of the staff. In fact the present director believes that he has too much supervisory authority and that his associates should be given more independence and made wholly responsible for their own work.

Men with training both in forestry and in their own specialty are preferred for investigations in such fields as forest entomology and forest pathology, but are hard to find. It is interesting to note, however, that the present director of the Station is a man who first studied forestry at the Hochschule für Bodenkultur and then took his doctor's degree in entomology at the University. No special provision is now made to train men for forest research, but the director of the Station has definite plans for doing this. He desires to obtain legislation under which he could permit members of the staff, while on full or part pay, to take such courses at the University or the Forest School as are necessary to equip them more adequately for their work. This would make it possible to develop a well-rounded forest pathologist, for example, either by getting a pathologist and allowing him to study forestry at Station expense, or by getting a forester and allowing him to study pathology. The Government would be fairly well protected in making such expenditures for the training of its own men, since it is regarded as scarcely ethical for a man once having entered public

service to leave it for private employment.

The present Station staff consists of three foresters, one of whom is also an entomologist, and a chemist specializing in forest soils. The latter confines himself to studying the properties of the soils themselves, while the influence of these properties on tree reproduction and growth is studied by the silviculturist at the Station. The director is very anxious to add to the staff men with thorough basic training in mathematics and in physics. The physicist is needed for studies of the physical properties of woods and of soils; while the mathematician is needed to assist in analysing all of the data obtained by the Station, particularly in the field of mensuration.

Two of the present staff (Dr. Sedlaczek and Dr. Tscherniak) do some teaching in addition to their research activities, but there is no organic connection between the Forest Experiment Station and the Forest School. The latter is, in fact, in the Ministry of Education. The men at the Station believe that complete separation of the two lines of work is desirable both because a man's full time is necessary for the most effective research and because greater continuity of policy, particularly in the continuation of long-time experiments, is possible at an experiment station than at a school.

The detailed program of work for the Experiment Station for 1926 is indicated in one of the enclosures accompanying this report. Its activities consist almost wholly in the continuation of experiments started prior to the war. Lack of funds makes it impossible to start much new work, and difficulty is experienced in maintaining properly

projects already under way.

The work in mensuration consists primarily in the re-numbering and remeasurement of permanent sample plots for the study of stand development and the effect of thinnings; in the making of such additional thinnings as are called for in the original working plans; and in the computation and analysis of the results. Thinning plots are usually established in groups of four, with three different degrees of thinning and a check plot. The area is ordinarily from 1-1/4 to 2-1/2 acres, with an isolation strip of about 100 feet. Narrower isolation strips were previously used, but did not prove satisfactory, and in a number of cases are now being widened. Each tree is numbered and a detailed record kept of its development. Difficulty is experienced in establishing groups of plots that are really comparable because of the rapid changes in soil conditions.

Comparatively little is being done in the field of forest pathology, which is theoretically covered by the man in charge of mensuration. In addition to his other duties, he also handles the five acre arboretum, which is one of the oldest in Europe, and the Station's forest museum.

The current work in silvics and silviculture consists chiefly in studies of existing plantations of exotics, of the annual production of spruce needle litter, and of the distribution of red beech in Austria with the causes therefor. The man in charge of the work also handles the Station's experimental area at Mariabrunn and the seed control tests, and serves during half of the year as editor of the "Centralblatt für das gesamte Forstwesen," which is published jointly by the Forest School and the Experiment Station. Studies of natural reproduction as affected by

various methods of cutting have previously been made, but apparently without the use of sample plots.

The work in forest soils includes studies of their chemical and physical properties and of the influence of different species on these. The work is much handicapped by lack of equipment. In general Dr. Rasnov believes that physical soil properties, such as texture, waterholding capacity, and acidity, are much more important than chemical properties, at least in the fairly good soils that are common throughout most of Austria. His studies have shown that the minimum amount of such elements as calcium, potassium, and phosphorus necessary for tree growth are nearly always present, and that additional amounts have little significance. They have also shown that the differences in these elements are often greater in the same forest type than in different forest types, such as pure conifers and pure hardwoods.

Nitrogen is important, but is usually present in sufficient amount in moderately good soils with a normal number of micro-organisms. In Dr. Rasnov's opinion it is made available chiefly by nitrogen-fixing bacteria, which he thinks are more commonly associated with the roots of most trees than has previously been believed. Except on very poor soils, he thinks that fertilizers have comparatively little influence on the growth of forest trees, and that manure is more important because of the effect of the straw in lightening the soil than because of the addition of nitrogen. Clear cutting has a bad effect because it exposes the soil to baking and drying out and because it greatly decreases bacterial activity.

Dr. Rasmov is also investigating the theory of Prof. Wiele of Berlin that fumes do not injure trees directly, but that they combine with nutrients in the soil to form more soluble salts which are then washed out and thus sterilize the soil. He finds that there is some influence of this sort, but that the major damage comes from the direct killing of the foliage by the fumes. In addition to his other duties he handles the library and the meteorological station. Meteorological observations formerly taken throughout Austria have had to be abandoned except for the one station at Mariabrunn.

The work in forest entomology deals largely with bark borers and the saw moth. It includes the development of control measures as well as studies in taxonomy and life history. Dr. Sedlacek is also studying the fauna in various forest types and its influence on their establishment and development, with special reference to the determination of any control measures that may be necessary.

All of the staff on request make special reports on the management of private forest properties. A charge is made for this work, of which 75 per cent is turned over to the general treasury, 15 per cent to the man who makes the examination, and 10 per cent to the director of the Station. This is not a very substantial source of income, however, the total receipts in 1925 amounting to only about \$240, of which the director's share was \$2.40. An effort is made to prevent this class of work from expanding sufficiently to interfere with the Station's investigative activities.

The Station also engages in a certain amount of extension, or public relations work, such as giving popular lectures and participating

in exhibits, with the object of bringing about better appreciation and support of its activities, and of getting the results of its studies actually applied in practice. Both Government officials and private owners follow its work rather closely.

The Station covers all of Austria, but is particularly active in the vicinity of Mariabrunn. There are no sub-stations. Permanent sample plots are chiefly on private land, where they have been almost wholly free from interference. The larger owners are really interested in the Station's work and consider it an honor to have plots on their lands. More offers of land are received than can be accepted and labor to assist in the establishment of the plots is often furnished by the owner. Considerable effort on the part of the Station was, however, necessary to arouse the interest that now exists.

The annual budget for the Station is now about 40,000 schillings, or approximately \$5,600. The attitude of the present Government toward forest research is not particularly liberal. Occasional gifts were formerly received from other sources, but are now rare. The salary of the director is 8,000 schillings (about \$1,120); for the other technical men it averages 5,000 schillings (about \$700). Living quarters are also included, and there is a very generous retirement allowance.

Publication of reports by the Station (*Mitteilungen aus dem forstlichen Versuchswesen Österreichs*) has been suspended since the war, but it is hoped can soon be resumed. The library gives the impression of being rather small and far from up-to-date, except so far as publications in the German language are concerned. The Station's relations with Germany are particularly close, and it has recently been made a member of

the German Union of Forest Experiment Stations (Verband der deutschen Versuchsanstalten).

Some research is carried on by members of the forestry faculty of the Hochschule für Bodenkultur at Vienna, which has an experimental area of its own near Mariabrunn. Aside from this work, which is probably less intensive and less well sustained than that at the Experiment Station, there is apparently little forest research in the country.

There is no question but that the Station was very hard hit by the war and that its recovery is slow. The staff is small and poorly paid, funds for travel and for the purchase of equipment are exceedingly limited, and library facilities are decidedly inadequate. My impression is that the Station is still in the doldrums and that in spite of its notable history it has less of interest to offer to American foresters at this time than a number of other stations in Europe.

CZECHOSLOVAKIA

Prior to the war Czechoslovakia, which at that time was a part of the Austro-Hungarian Empire, had neither a forest school nor a forest experiment station of its own. Many of the sample plots which had been established in the eastern part of the country by the Austrian Forest Experiment Station at Mariabrunn were seriously damaged during the war, and the Hungarian station at Banská Štiavnica (in Slovakia) was completely destroyed. It was therefore necessary to build the investigative work practically from the ground up.

Interest in all phases of forestry has been very keen in Czechoslovakia ever since the establishment of the Republic in 1918. A comprehensive land reform program has been undertaken which involves, among other things, increasing the area of State forests from about 16 to 25 per cent of the total land area; legislation has been enacted providing for the conservative management of both public and private forests; advanced courses in forestry have been established at the Polytechnic High School in Praha (Prague) and at the Agricultural High School in Brno (Brünn); and an ambitious program of forest research has been inaugurated. Just how the latter will eventually develop is, in my judgment, still somewhat uncertain.

Forest research is in the Ministry of Agriculture under the immediate supervision of the Director General of Lands and Forests. The latter, Dr. Ing. Karel Šíman, formerly forester for Prince Lichenstein, is an exceedingly aggressive and energetic man of middle age who appears to be at present virtually a dictator in nearly all forest activities in Czechoslovakia. As in Austria, there is an independent bureau in the

Ministry of Agriculture (under Ing. Klement Zeman) which inspects the management of public as well as of private forests. Unlike Austria, however, forest research in Czechoslovakia is attached to the administrative rather than to the inspective branch of the service.

The work is divided by lines of activity into six distinct units. These are sometimes referred to as "sections" and sometimes as "forest research institutes". The latter term, which implies a greater degree of autonomy, is the one ordinarily used by the heads of the different units, each of whom apparently regards himself as the director of a separate organization. In actual practice each unit seems to be largely independent except for its responsibility to the Director General of Lands and Forests (Dr. Siman). The important point in connection with the organization is not the nomenclature used but the fact that the only really effective control and correlation of research activities are exercised by an official who is exceedingly busy with other pressing administrative duties.

Additional correlation is theoretically provided by a "special commission for the administration of forest research". This consists of the chiefs of the different sections, or institutes, under the chairmanship of a representative of the Minister of Agriculture. It considers all matters connected with the administration of the institute, but particularly their proposed programs of work. Other employees of the institutes, as well as foresters not engaged in investigative work, may be invited to participate in its discussions. The commission acts only in an advisory capacity to the Minister of Agriculture, who takes final action.

There is also a body for the administration of agricultural research, apparently with real power, composed of the heads of different lines of agricultural research (agronomy, animal husbandry, agricultural economics, forestry, etc.) , which determines the administrative policies common to all lines of work, fixes the budgets, etc. Finally, there is an unofficial "Association of Institutes for Agricultural Research in the Republic of Czechoslovakia" for the consideration of matters of common interest, to which the forest research institutes belong, and which acts in a way as an adviser to the Minister of Agriculture.

The 6 sections, or institutes, into which the forest research work is now divided, with their personnel, headquarters, and the lines of activity particularly stressed in the present programs of work, are as follows:-

1. Biochemistry, - Dr. Ing. Antonín Němec, in charge; Dr. Techn. Karel Kvapil, assistant; Praha. Dr. Němec is a chemist and soil scientist who is also the head of the Institute for Plant Production and Agricultural Chemistry at the Polytechnic High School in Praha. Dr. Kvapil is a forester who devotes his entire time to the work of the Biochemical Institute.

Investigation of all problems relating to the physiology and biochemistry of forest vegetation; mechanical, physical, chemical, and biological properties of forest soils; influence of different soils on the quantity and quality of wood production, and of stands of different species, ages, and densities on soil conditions. Special attention is now being given to the biochemistry of trees, to the formation and character of humus, to the inter-relation between soil properties and forest stands, and to the use of fertilizers in nurseries.

2. Forest Protection, - Dr. J. M. Krmárek, in charge; one assistant in 1926, probably two in 1927; Praha. Dr. Krmárek is primarily an entomologist and pathologist, who is also a professor at Karlov University.

Investigation of the protection of the forest from insects, disease, and other destructive agencies, including the determination and organization of control measures. Special attention is now being given to studies of forest insects, notably *Limantria monacha*, *Hylebius abietis*, *Cecidomyia brachyntera*, *Lyptus dispar*, *Ips typographus*, and *I. cembrae*; and of the progressive disappearance of fir in western Bohemia. The Institute has inaugurated a system by which regular reports of insect activity are received from State officials and from foresters in private employ.

3. Silviculture and Forest Biology, - Ing. Josef Krmáček, in charge; no assistant; Brno. Prof. Krmáček is a forester who also teaches as one of the forestry faculty at the Agricultural High School in Brno.

Investigation of the biological characteristics of forest trees, with special reference to heredity; relation of trees to their environment; introduction of exotics; source of seed; nursery practices; treatment of forests; methods of cutting to secure natural reproduction. Very little work has so far been done. The program calls for immediate emphasis on maintenance of the former sample plots of the Austrian and Hungarian experiment stations; establishment of phenological observations; establishment of an arboretum and nurseries, with special reference to exotics; determination of the influence of various cultural methods on growth; production of forest trees in pastures; organization of seed

collecting from particularly choice stands; determination of new methods of seed control.

An office at Praha which handles the actual seed testing work is theoretically a part of this institute but in practice is virtually independent.

4. Forest Management, - Dr. Ing. Rudolf Hana, in charge; no assistant; Brno. Prof. Hana is a forester who also teaches as one of the forestry faculty at the Agricultural High School in Brno.

Investigation of all problems in the field of forest mensuration, regulation, and valuation, with special reference to timber estimating and the preparation of volume and yield tables. Special emphasis is now being placed on aerial photography; methods of studying yield as a basis for regulating the cut; and maintenance of the former mensuration sample plots of the Austrian and Hungarian forest experiment stations.

5. Forest Utilization, - Dr. Ing. Vladimír Hruban, in charge; no assistant; Banásk Stávnice. Dr. Hruban is a forester who devotes his entire time to the work of the Institute. His headquarters were temporarily in Praha in 1926, but he expected to move to Banásk Stávnice either that fall or the next spring.

Investigation of all problems in the fields of forest and wood utilization. Work is being concentrated for the present on wood-destroying fungi and timber preservation; seasoning of wood; uses of bark; and testing of other materials as a means of conserving wood.

6. Forest Policy and Economics. This Institute has been planned, but had not been actually established up to June, 1926.

Provisional headquarters are to be at Praha.

Investigation of all problems in the field of forest policy and economics. The first work to be undertaken will include a study of the factors influencing the practice of forestry in Czechoslovakia; the preparation of a forest code; and the collecting of information of value in connection with the land reform movement.

It will be noted that of the 5 heads of Institutes only 3 (Konešl, Haša, and Hruban) are foresters, that only one (Hruban) devotes his entire time to the work, and that he is expected to cover the entire field of the Forest Products Laboratory. Special projects may be assigned to men not connected with the institutes, but so far as I could learn this has not yet been done.

The duties of the forest research institutes are decidedly comprehensive. They are expected not only to conduct original investigations and to demonstrate and popularize the results obtained, but also to determine the best means of putting into practice facts already known, to advise on the application of scientific information in specific cases, to assist the State inspection service in bringing about desirable forest practice, and to certify the quality of certain forest products (for example, tree seeds). Great emphasis is laid on making the work of practical value.

Branch stations are to be established, each with a local officer in charge, in connection with the State schools of middle and ranger grade at Písek and Zakupy in Bohemia, at Hranice and Jesenice in Moravia, at Liptovský Hrádek and Kysličky (near Banská Štiavnica) in Slovakia, and at Ushored in Subcarpathian Russia. Experiments are to

be concentrated at these stations. From an administrative point of view they report to the Director General of Lands and Forests, while from a technical point of view they carry out the instructions of the heads of the different institutes. Close cooperation between the latter is counted on to prevent any conflict of interest in the use of the branch stations.

The Agricultural High School at Brno has a near-by forest of 7,130 hectares (about 17,600 acres), which was recently expropriated as part of the land reform movement and turned over to the school for instructional and experimental purposes. There is a local forest supervisor (Dr. Ing. Alois Hubiče) and an experimental sawmill at the headquarters village of Adamov.

The present appropriation for forest research is 1,000,000 kroner (about \$30,000). Increases are expected as the needs of the work demand. Salaries are low (one director gets only about \$750 a year), and are said to fall considerably short of those received by foresters in private employ.

The forest research service as yet has no publication of its own. Results of investigations are printed in the various forestry periodicals, of which the best are "Československý Les", published by the Central Union of Czechoslovakian Foresters, and "Lesnická Práce", published by the Society of Czechoslovak Foresters.

In addition to the activities of the several institutes some forest research is being conducted by the Agricultural Experiment Station of the Province of Moravia at Brno. This station has a staff of 7 men, 2 of whom (Ing. Jaroslav Rašek and Ing. Octaviansus Farký) are handling respectively forest entomology, and forest pathology and ornithology. The latter was to be transferred to the Institute for Forest

Protection in 1927. Apparently little research is done by professors at the forest schools except in so far as these are members of the research institutes.

The Czechoslovakian authorities recognize frankly that the proposed plans for forest research will have to be put into effect gradually and may need modification as the work develops. Whether real correlation of effort and effective prosecution of the work will prove possible with the rather scattered and largely part-time personnel now employed, still remains to be seen. So far each institute has even maintained its own library and its own files. There will be some consolidation in these respects so far as the units in Prague are concerned when the new forestry building now under construction is completed.

So far the only institutes which are really under way are those for Biochemistry and for Forest Protection. The former is doing some fundamental work of great interest with forest soils. Dr. Hanes is a brilliant investigator and has a capable assistant in Dr. Kvapil, who also has the advantage of being a forester.

Copies of many of Dr. Hanes's publications, including some dealing primarily with agricultural problems, accompany this report. It will be noted that these cover a wide field and that a distinct attempt is made to correlate soil properties with tree growth, particularly with reference to the influence of pure and mixed stands. Some of the broader conclusions of general interest are that humification is most rapid with hardwoods and with less acid soils; that nitrates are more abundant in hardwood stands and in mixed stands than in coniferous stands; that soil aeration is better in hardwood and mixed stands than in coniferous stands;

that hardwood and mixed stands have a more favorable influence on the physical, chemical, and biochemical properties of the soil; and that this influence is more marked in the mineral soil than in the humus.

Dr. Hemes and Dr. Kvapil are the outstanding investigators in Czechoslovakia with whom it is particularly desirable for American foresters to keep in touch at this time. With the exception of Dr. Komárek's investigations in forest entomology, the work of the other institutes is still in the formative stage. There is no doubt, however, as to the interest in forest research, and it is not at all unlikely that the ambitious plans for its development will be largely realized. Close observation of the progress of the work will therefore be well worth while.

GERMANY

Germany has seven forest experiment stations located at München, Freiburg, Giessen, Tharandt, Eberswalde, Tübingen, and Braunschweig. Of these I visited only the one at Tharandt near Dresden (sächsische forstliche Versuchsanstalt). This is entirely a Saxon institution and is not in any way supported or controlled by the central government at Berlin. It was established in 1872 at the very beginning of the forest experiment station movement.

The station is so closely connected with the Forest School at Tharandt (sächsische forstliche Hochschule), the oldest forest school in Germany, as to be virtually a part of it. The personnel of the two institutions is identical, members of the Forest School being automatically members of the Experiment Station. Salaries are paid by the School, which receives a total appropriation of 235,700 marks (about \$57,300). The station proper has an annual appropriation of only 18,900 marks (about \$4,600), used chiefly for travel, supplies, and equipment.

The rector of the School is elected annually by the members of the staff and serves also as director of the Forest Experiment Station. He represents both institutions in their outside contacts, but exercises practically no supervision over the investigative activities of his colleagues, who virtually determine their own program of work.

Teaching schedules are purposely made light, seldom averaging over 5 or 6 credit hours per week, so as to allow ample opportunity for research. The men at Tharandt seemed very decidedly

of the opinion that it is highly advantageous to both lines of work to have them handled by the same individuals. They therefore favor combining the two activities in what really amounts to a single institution. On the other hand, the prevailing policy in most of the other European countries is to draw a rather sharp line between the forest experiment stations and the forest schools. This is not so much to discourage research at the schools as to protect the men at the stations from the distractions which teaching is believed to involve, and thus enable them to devote their entire time and attention to the primary business of research.

Both the Forest School and the Forest Experiment Station in Saxony come under the Bureau of Forestry (Landesforstdirektion, Landforstmeister F. Roth), which in turn is part of the Ministry of Finance. Supervision is largely nominal, however, and apparently involves little more than an annual inspection visit of a few hours. Practically the School and the Station are pretty free to determine their own policies and programs of work, subject of course to the limitations set by their respective budgets.

The foresters at Tharandt, with the subjects covered by each, are as follows:

Geh. Forstrat Professor i. R. Dr. Martin, forest management, (retired).

Professor Bernhard, Landforstmeister A.D., forest management.

Geh. Forstrat Professor Gross, forest utilisation.

Professor Dr. J. Basse, Forest mensuration, and Director of the Station in 1926.

Professor Dr. Münch, forest botany and forest pathology.

Professor Dr. Wiedemann, silviculture.

Professor Dr. C. Krauss, silvics and forest soils.

Professor Dr. Jentsch, forest policy and economics.

Oberförster Sachse, elements of forestry.

Other members of the staff who are not foresters, with the subjects which they teach, include:

Professor Dr. Wislicenus (a son of the botanist), chemistry.

Professor Dr. Rugerschoff, mathematics, surveying, and forest road construction. Also has an office with Gustav Heyde, Kleiststrasse 10, Dresden Neustadt 23, where he is making an intensive study of airplane photography.

Professor Dr. Frell (in this country last year on an International Education Board fellowship), forest zoology.

Professor Dr. Holldack, forest law.

Honorary professor Dr. Schreiter, geology and mineralogy.

Privatdozent Dr. Gierisch, biochemistry.

Privatdozent Dr. Lorenz, physico-chemical foundations of natural science.

Assistant Dr. Bavendamm, systematic botany, anatomy, morphology, and physiology of plants.

Sportrat Schmuntzsch, physical culture.

No special provision is made for the training of research men.

Tharandt is practically surrounded by woods, and this fact has been used as one of the strongest arguments against the proposed

removal of the school to the Technical College at Dresden, or to the University at Leipzig. The School and Station have an instruction and experimental forest of their own on the outskirts of Tharandt, and also have the oldest and best known arboretum in Germany. It is here that Cotta is buried. They also have the privilege of using any of the State Forests, one of which has its headquarters at Tharandt.

The activities of the Experiment Station were of course affected adversely by the war, although not nearly to the same extent as those of the Austrian Station at Mariabrunn. There is now a full staff, and a reasonable appropriation is available for travel and the purchase of equipment. The library is a good one, but by no means complete so far as American publications are concerned.

One of the chief interests of the Station is in the deterioration of the pure spruce stands in Saxony. This is particularly noticeable at elevations below the natural range of the spruce and on soils where lime is lacking. Prof. Wiedemann, who is making a special study of the problem, states that on other sites little or no difficulty is experienced in maintaining normal yields from pure stands. Where deterioration is taking place he believes that this is due to the formation by spruce and fir needles of substances which have a toxic effect on spruce, possibly through their action on beneficial soil bacteria, and that these toxins are neutralized by lime.

Whatever the cause, there is now a decided tendency to replace the pure spruce stands, which at one time were so strongly favored, by mixed stands having a liberal representation of beech. Where beech does not come in naturally on cut-over areas it is even being planted, not with the idea that it will form part of the main

crop but for its beneficial influence on the soil. The problem is still being actively studied, although so far as I could determine no concerted and exhaustive attack on it is being made through the joint efforts of foresters and soil scientists. Lack of such cooperation, in fact, seems to me one of the greatest weaknesses in much of the forest research in Europe.

Prof. Wiedemann is also studying a mysterious deterioration of the silver fir which seems to be taking place throughout southern Germany. It is thought that a louse may have something to do with the phenomenon, but no cause which appears to offer an adequate explanation of the trouble has yet been discovered.

Prof. Krauss, a former assistant of Ramann's who went from Munich to Tharandt in November, 1925, has been specializing in the mechanical analysis of forest soils, and has invented a washing apparatus for this purpose which apparently gives excellent results (description attached). He has also made some studies aimed at correlating the mineral content of tree leaves with the mineral content of the soil in which they grow. His energy and enthusiasm, coupled with his training under Ramann, give promise of real achievement in forest soil investigations. His attendance at the recent Soil Science Congress in Washington, and his subsequent trip to the West Coast and back will also give him a fairly good idea of forest conditions in this country.

Studies of methods of cutting and of thinnings are being conducted by the usual sample plot methods. In general it strikes me that the thinnings are too light and that over-dense stands are not opened up enough to permit of their best development.

Prof. Münch is doing some intensive work on the viability

of pollen grains and on the distance to which they are ordinarily distributed in a viable condition. I did not have an opportunity to talk with him, but he has the reputation of being an able investigator in the field of forest botany.

Prof. Frell, a zoologist, covers the whole field of forest zoology, but is particularly interested in entomology, with special reference to bark borers and the saw moth.

Prof. Wislicenus, a chemist, is studying chiefly wood chemistry (tannins, dyes, etc., including the artificial coloring of trees by vegetable dyes), and the effect and control of fumes. His interests are primarily with forest products, and he is doing nothing in the field of soil chemistry.

Prof. Hagershoff, an engineer and physicist, has been a pioneer in airplane photography, which he seems to have developed to a high degree of efficiency. His chief contribution is the invention of an autographic instrument by which topographic maps and plaster models can be made directly from airplane photographs (description attached). The instrument is said to cost approximately 350,000 marks (about \$85,000).

The results of investigations at the Forest Experiment Station are published chiefly in the "Tharandter Forstlichen Jahrbuch" and in the "Mitteilungen aus der Sächsischen Staatlichen Forstlichen Versuchsanstalt Tharandt", and to a less extent in other German periodicals.

Except for occasional minor studies by forest officers, there is very little forest research in Saxony outside of Tharandt. Some studies in soil bacteriology and nutritive plant physiology are being made by Dr. Neubauer at the Botanical Institute in Dresden, but

these deal much more with other plants than with forest trees.

The Experiment Station at Tharandt did not seem to me to be accomplishing quite as much in the way of forest research as would be expected from its size, but this is perhaps due to the teaching activities which must also be handled by members of the staff. I would not go so far as an Argentine forester (Fabelt) who expressed the view that the institution is "just a little bit fossilized ". It strikes me as doing substantial and worth while work, particularly in the fields of silviculture and forest soils, and I believe that the activities of Prof. Wiedemann and Prof. Krauss are likely to prove of special interest to American foresters.

FINLAND

The need for a forest experiment station in Finland was discussed as far back as 1866. The first real step toward its establishment was not taken, however, until 1906 when Prof. A. K. Cajander was appointed by the Government to study the organization of forest research in other countries and to prepare plans for initiating similar work in Finland. His report, which recommended the establishment of a Forest Research Institute, was printed in 1909. Plans to put these recommendations into effect were temporarily blocked by the outbreak of the war.

The interest of the Finnish people in forestry is well illustrated by the fact that active steps to establish the proposed Institute were taken by the new native government within a few months after the overthrow of the Russians. The statutes for the establishment of the Institute were issued on October 24, 1917, and its activities commenced on July 1, 1918.

The purpose of the Institute is "by investigations and experiments to elucidate the fundamentals of rational forestry and those facts upon which the forest productivity of Finland depends". This is broad enough to enable it to conduct investigations in practically any field. So far, however, the work has been confined chiefly to silviculture, mensuration, and soils.

The Institute, which is located at Helsinki (Helsingfors), is divided into three distinct departments. The personnel of these is as follows:

Department of Silviculture, Prof. Dr. Olli Heikinheimo, Director of the Station, in charge; Dr. V. Rajala, assistant.

Department of Forest Mensuration and Valuation, Prof.

Dr. Yrjö Ilvessalo, in charge; Mag. phil. M. Leppi-Seppälä, assistant.

Department of Forest Soils, Prof. Dr. V. T. Aaltonen, in charge; assistantship vacant.

There are also 2 clerks and 2 foresters detailed from the Board of Forestry to assist in the sample plot work. The proposed budget for 1928 provides for the establishment of three new departments, each with a chief and an assistant, covering forest utilization, forest economics, and swamp studies, with two additional clerks.

Administratively the Forest Research Institute is under the Division for Private Forestry in the Board of Forestry, which in turn is part of the ministry of Agriculture. This connection is hardly more than nominal, however, and the Institute has its own Board of Administration, which is composed of the heads of departments and one or more professors of forestry at the University of Helsinki designated by the government. It is thus virtually independent except in so far as the Director General of the Board of Forestry (Prof. Cajander) tends to dominate all forest activities in Finland.

The heads of departments have the title of "professor" and must have the same qualifications as professors at the University. The position is one of considerable distinction and great care is taken to appoint only men of outstanding ability. When a vacancy occurs candidates are encouraged to apply, and their qualifications are thoroughly investigated by a special committee under the chairmanship of the Director General of the Board of Forestry. Other members of the committee include the professors of forestry at the Institute and the University, an appointee of the Board of Forestry, and representatives from other countries who are recognized authorities in the field concerned.

Thorough scientific training and research ability are the most essential requirements. Practical experience is important but less essential. Foresters are preferred, and all of the heads of departments have so far been graduates of a forest school. This is not an absolute requirement, however, and thorough knowledge of the individual's specialty is regarded as more important.

If exactly the right man cannot be found, the position is filled only temporarily. For example, Dr. Aaltonen of the Department of Forest Soils acted under a temporary appointment from 1923 to March, 1927. Each department head has a technical assistant, who works more or less independently, and the necessary clerical help. Aside from the experience automatically acquired by those in subordinate positions, no special effort is made to train men for research either in school or in the Institute itself. Men particularly interested in this field are expected through their own efforts to acquire the training and experience necessary to warrant their appointment.

In addition to the regular staff, special investigators are occasionally attached to the Institute for the conduct of specific studies. Dr. Väinö Auer, for example, is now serving as a special investigator for swamp problems.

Department heads and their assistants prepare their own programs of work which are reviewed, and usually approved without modification by the Board of Administration. The Director of the Institute is also elected by the latter for a three year term and is eligible for re-election. Dr. Heikinheimo has served in this capacity from the beginning. The director represents the Institute in its outside contacts and handles various administrative details, but exercises virtually no control over

the other members of the staff.

The appropriation for the Institute is allotted to it in a lump sum and is divided among the different departments by the Board of Administration. The budget for 1926 was 670,500 Fmk. (about \$16,890), exclusive of the appropriation for the maintenance of the experimental forests. A budget of 1,200,000 Fmk. (about \$30,000) is proposed for 1928 to permit of the desired expansion of the Station. The salary of individual professors is 63,000 Fmk. (about \$1,575).

The experimental forests constitute a rather unique feature of the Finnish Forest Research Institute. There are 17 of them in different parts of the country varying in size from 15 to 40,000 acres, with a total area of 132,000 acres (53,700 hectares). In addition to serving as research and demonstration forests, they are intended to give the officers of the Institute practical experience in the actual management of a forest property. Complete administration of these forests, including the preparation of working plans and the handling of timber sales, is therefore turned over to the Institute. A special appropriation for the purpose is included in the budget for State Forests, and all receipts go to the general treasury. Supervision of the work is entrusted to the head of the Department of Silviculture, who is assisted by a permanent force of 3 technical foresters (A. Sandman, A. Sandholm, and V. Linkkala) and 10 or 11 rangers. The former have their headquarters at the Forest Research Institute in Helsinki, while the latter are permanently stationed in the field in local charge of the experimental areas. Supervision of these requires a large share of the time of the director of the Institute, but the advantages of the arrangement are believed to more than offset the resulting interference with his own investigations.

Other State Forests are also used so far as necessary for investigative purposes. Permanent sample plots are now confined to publicly owned lands as the only means of assuring freedom from interference. Private lands are of course used without hesitation for temporary plots.

The Department of Silviculture is devoting its attention chiefly to studies along the following lines:

Natural reproduction in different types under natural conditions, after burning, and after various methods of cutting.

Methods of sowing and planting.

Introduction of exotics, particularly from North America, Japan, and Siberia.

Source of seed, with regard to the influence both of locality of origin and of the parent tree.

Phenological observations.

Forest pathology.

Cause of curly birch, which is so valuable that the wood is sold by weight rather than by volume.

The work is for the most part along lines similar to those followed in this country, and the methods used are those with which we are already familiar. Special attention should perhaps be called to the importance attached to source of seed, from the standpoint both of heredity and of climatic varieties. The success of artificial reproduction is regarded as largely dependent on the locality and on the character of the trees from which the seed was obtained.

The Department of Forest Mensuration and Valuation has so far been occupied chiefly with the preparation of volume and yield

tables and with the forest survey of the entire country. The chief points of interest in connection with the yield tables are that individual stands are assigned to sites in the field on the basis of the forest type classification developed by Cajander, that plot volumes are determined entirely by the use of sample trees, and that statistical methods are invariably used in the preparation and checking of the tables. It is anticipated that a series of normal yield tables for the country will be completed in about another year. No satisfactory method for applying normal tables to abnormal stands has yet been worked out.

The actual survey of the forests of Finland, which had been preceded by intensive studies to determine the best methods to use, was carried out in 1922 and 1923. Work in the State Forests was done by the Board of Forestry and in other forests by the Forest Research Institute, the survey as a whole being under the direction of Prof. Ilvessalo. Two publications, one of which is in English, have already been issued dealing with the present stand, annual growth, and silvicultural condition of the forests of the country. A single comprehensive publication, giving the results of the survey in more detail, is now in preparation.

The project is of great interest to this country because of the possibility of adapting the methods used to a similar survey here. As an illustration of this may be cited the fact that ocular estimates, which were largely depended on, were found to give very accurate results when modified by correction factors determined by statistical methods. For example, the coefficient of relation between ocular estimates and actual measurements was 0.902 ± 0.016 in the case of volume, and 0.800 ± 0.024 in the case of growth. The accuracy of linear surveying was also found to depend much more on the distance between the lines than on the

width of the lines themselves.

In addition to these main projects the Department of Forest Mensuration and Valuation is establishing permanent sample plots for the study of growth and yield in thinned stands and in managed stands with different degrees of stocking. The plots usually average about one-quarter acre in size and are handled by much the same methods as here. Practically every plot is used for educational purposes by posting information as to the object of the work, total stand, amount removed in thinnings, and other points of interest.

The chief project of the Department of Forest Soils is to work out the relationship between soils and forest types. By intensive studies of various soil properties it is hoped to determine whether the distinctive vegetation by which forest types are now recognized can be correlated with significant and consistent differences in the soil itself. If so, it is believed that this will constitute convincing evidence of the soundness of the forest type theory.

Work has so far been largely on soil acidity, with some attention to the decomposition of nitrogenous compounds and to the distribution of root systems. Last year Prof. Aaltonen planned to continue his studies of acidity, and also to investigate the decomposition of cellulose compounds and the accompanying production of carbon dioxide. The work has so far been somewhat handicapped by lack of equipment. Prof. Aaltonen believes studies of acidity, nitrogen, calcium, and possibly potassium to be of primary importance. Work with soil micro-organisms he regards as too theoretical to be of much value at this time.

Permanent sample plots now number between 250 and 300. The sample plots are used so far as possible for studies by all three departments

both for the sake of economy and as a means of bringing about better correlation and interpretation of results.

The investigative work of the Institute, as well as of other research agencies, has been greatly influenced by Cajander's theory of forest types. This is fully described in his recent publication (in English) on the subject, in which he sets forth the value of the conception in silviculture, mensuration, policy, and in fact practically every phase of forestry. The theory, which Cajander hopes will in time be adopted throughout the world, deserves more detailed field study than it has so far received in this country.

The major results of the Institute's work are published in "Metsätieteellisen Seuran Julkaisuja" (Contributions from the Finnish Forest Research Institute), of which 10 volumes have so far been issued. Articles are also published in the proceedings of the Society of Forestry, mentioned later, and occasionally in other periodicals. Among the latter may be mentioned "Metsätaloudellinen Aikakauskirja" and "Forstlig Tidskrift", published by the Finnish Forestry Association, (an organization with about 1,500 members corresponding roughly to the Society of American Foresters); "Tapio", published by Suomen Metsähoitoyhdistys Tapio (an organization of district agricultural societies); and "Metsänvies", published by Metsämiehen Keskusseura (an association of forest rangers).

The Forest Research Institute has been kept entirely distinct from the forest school at the University of Helsinki, which is under the Ministry of Education, on the ground that investigative work is conducted most effectively by men able to devote their entire attention to it. At the same time members of the Institute may give courses,

usually of 2 hours a week, at the University; while professors at the University are offered special facilities for individual research at the Institute.

The Society of Forestry in Finland, organized in 1909 on the initiative of Prof. Cajander, for the purpose of stimulating research, has been very effective in this direction. It was largely responsible for the establishment of the Forest Research Institute, has stimulated research by other agencies and individuals through subsidies and otherwise, and makes available the results of investigations in a publication entitled "Acta Forestalia Fennica", of which 30 volumes have so far been issued. The Society in 1926 had a membership of 133, and received an annual grant from the Finnish Government of Fmk. 100,000 (about \$2,500), the bulk of which is used for printing and exchange of publications.

Investigations by individuals have covered a wide field, including forest protection, forest production, forest management, forest economics, and to a less extent forest and wood utilization. Special mention should be made of the extensive arboretum for the testing out of exotics established by A. G. Tigerstedt at Mustila early in the present century. Investigations by other agencies are welcomed by the Forest Research Institute, which confines its activities largely to projects of too great scope to be undertaken successfully by individuals.

The items of particular interest in connection with forest research in Finland may be summarized briefly, as follows:

The practically autonomous position of the Forest Research Institute in the Board of Forestry.

The complete separation of State activities in the fields

of forest research and forest education.

The organization of the Institute into three virtually independent departments covering silviculture, forest mensuration, and valuation, and forest soils.

The proposed expansion of the work to practically double its present scale.

The emphasis placed on obtaining the very best available men and then giving them a free rein.

The administration by the Institute of 132,000 acres of experimental, demonstration, and practice forests, with local rangers in charge.

The dominating influence of Cajander's theory of forest types, and the practically universal use of statistical methods, in all phases of forest research.

The assignment of such a task as the forest survey of Finland to the Research Institute.

The growing emphasis placed on fundamental research, particularly in forest ecology and forest soils, as opposed to the empirical tests and experiments which have previously prevailed.

The important part played by the Society of Forestry in stimulating forest research and its close cooperation with the Forest Research Institute.

The keen interest taken by Finnish foresters in the development of forestry in the United States and their desire to establish more intimate relations with American foresters.

SWEDEN

The Swedish Forest Research Institute (Statens Skogsforsöksanstalt) was established in 1902 with a forester, a botanist, two assistants, and an appropriation of 16,000 Kr. (about \$4,200). Since then it has grown until it now has a total staff of 22 persons, a fine building of its own at Experimentalfältet, near Stockholm, and an annual appropriation of 200,000 Kr. (about \$52,500).. It is thus much the largest of any of the forest experiment stations that I visited, and in all probability in Europe.

The Institute is in the Ministry of Agriculture, but has no connection with the State Forest Administration (Kungl. Dominstyrelsen, General Direktor K. J. Beskow). It has a Board of Administration consisting of 5 members appointed by the King. This board passes on the budget and on matters of general policy, but pays little attention to the program of work or to technical details. Its composition is identical with that of the Board of Administration for the Forest High School (Skogshögskolan, Rektor Tor Jonson), but otherwise there is no official connection between the two institutions. The Forest Research Institute therefore occupies an independent position of considerable prominence and much strength.

The Institute has four distinct Departments, three of which are permanent and one temporary. These, with the principal personnel in each, are as follows:

Department of Forestry, - Prof. Jägästare Henrik Pettersson, in charge; Jägästare Sven Petrini and Jägästare Erik Lundh, assistants; 6 rangers, 3 of whom are in charge of experimental forests; 3 female clerks.

Department of Natural Science, - Prof. Dr. Henrik Hesselman, in charge; Dr. Olof Tamm, Dr. Lars-Gunnar Romell, and Dr. Carl Malmström, assistants; 2 female chemists.

Department of Forest Entomology, - Prof. Dr. Ivar Trägårdh, in charge; Dr. Paul Spessivtseff, assistant.

Department for Regenerational Research in Norrland, - Jagmästare Edvard Wibeck, in charge; Kronojägare Folke Harald, assistant.

Professors Hesselman and Trägårdh also teach regularly at the Forest High School, and some of the others give occasional lectures there.

The first three departments are permanent. The men in charge must have the same qualifications as professors at the Forest High School, receive the same salary, and have the title of "professor". The fourth department is a temporary one, organized in 1916 for intensive study of the exceptionally difficult problems in regeneration due to the severe climate of northern Sweden. It was originally expected to function for 15 years, or until 1931, but may have to be continued longer.

All of the technical personnel in the Departments of Forestry and of Regenerational Research in Norrland consists of foresters. In the Department of Natural Science Prof. Hesselman was originally a botanist, who later specialized in soil science and has also acquired a good knowledge of forestry; while Drs. Tamm, Romell, and Malmström are all doctors of philosophy without any school training in forestry who are specializing respectively in soil science, in physiology, and in the formation, characteristics, and utilization of peat bogs. In selecting men, a thorough knowledge of the field in which each is to specialize is regarded as the most important qualification. Some

knowledge of forestry is regarded as highly desirable but less essential than mastery of the individual's specialty. No particular effort seems to be made to train men for forest research either before or after they enter the Institute.

Heads of Departments are appointed for life and are chosen with great care. When a vacancy occurs, candidates are encouraged to apply for the place, and a special committee is appointed by the Board of Administration to consider their qualifications. This committee, usually after lengthy deliberation, lists the candidates in what it regards as their order of merit. The Board then considers the report of the Committee, and finally recommends 3 persons to the King, who practically always appoints the first man on the list.

One of the heads of Departments is named by the King, on the recommendation of the Board of Administration, to serve as Director of the Institute for a term of 3 years, at the end of which time he may or may not be reappointed. Prof. Hesselman is the present director. In addition to his salary of 15,500 Kr. (about \$3,500) a year as head of a Department, the director receives 700 Kr. a year (about \$135) for serving in that capacity. He represents the Institute in its outside contacts and handles various administrative matters pertaining to the Institute as a whole, but exercises practically no control over the different Departments.

Every 5 years each Department head prepares a program of work which is considered by a special committee appointed by the Board of Administration. This committee reviews the programs with a view to determining whether the projects proposed are thoroughly worth while and to bringing about as complete correlation as possible between the

Departments. It seldom makes any radical changes in the programs proposed by the Department heads, who are pretty independent both in the planning and the execution of their work.

The Department of Forestry covers primarily the fields of silviculture and forest mensuration. Thinnings have been particularly emphasized, and about 600 permanent sample plots to determine the effect of various degrees of thinning in stands of different type and density have been established throughout the country. Much of this work strikes me as being rather extensive in character. The individual trees are often not numbered, the plots in a given series do not always seem to be wholly comparable, and in some instances there are no check plots. In the latter case it is assumed that the influence of any given operation can be determined by the behaviour of the stand before and after treatment. The general theory seems to have been that it is better to obtain rather extensive data from a large number of plots than to work more intensively on a much smaller number.

Much attention has also been paid to determining the importance of source of seed in artificial reforestation, particularly with Scotch pine, which seems to be much more variable in this respect than Norway spruce. Some 450 permanent sample plots have been established for this purpose. In general the best results are obtained with local seed.

Other studies include methods of sowing and planting, the value of exotics, the reforestation of long-barren heaths, methods of cutting to secure natural reproduction, and the preparation of volume and yield tables. This Department also exercises general supervision over the experimental forests which will be mentioned later.

The Department of Natural Science is at present centering its attention largely on forest soil problems. Among these are included the mobilization of nitrogen in the humus layer; the influence of nitrogen on tree reproduction and growth; soil moisture, acidity, and aeration; the formation of "podsol" and "brown earth" soils; and the development and characteristics of peat bogs. Prof. Hesselman's interesting work in this field is pretty thoroughly presented in his recent publication entitled "Studies of the Humus Layer in Coniferous Forests, Its Characteristics, and the Way in Which It Is Influenced by Silviculture". The German summary of this has been translated by Messrs. Gast and Stickel.

Dr. Hesselman has tried to prove his theory as to the importance of nitrogen by two field tests with artificial fertilizers. In one of these he laid out 3 adjacent plots each one meter square and treated these once a week respectively with 10 liters of distilled water, 10 liters of ammonium sulphate solution, and 10 liters of ammonium nitrate solution. No change was noted in the reproduction and other vegetation on the first plot. Both of the treated plots, however, improved considerably in appearance and rate of growth, with the best results on the plot treated with ammonium sulphate. Prof. Hesselman thinks that the plot treated with ammonium nitrate probably received an excess of nitrogen.

In the other experiment, two sample plots each 10 meters square have been laid out in a mature stand of Norway spruce. One plot is watered each week with 1,000 liters of brook water (equivalent to 10 mm. precipitation), the other with 1,000 liters of brook water

to which 80 grams of ammonium nitrate have been added. A ditch between the two plots prevents the water from running from one to the other. The experiment was started in the spring of 1924, and in 1926 Prof. Hesselman thought he could already detect a thrifter, more vigorous appearance in the fertilized plot. He believes that it will be of great importance if he can prove that even old trees are helped by the addition of nitrogen. The influence of the latter appears first in the color of the foliage and in the length of the needles, and later in the rate of growth.

Prof. Hesselman is making a laboratory study of the effect of fire on nitrification and acidity by subjecting forest soils for 5 hours to constant temperatures of 50° and 100° C. No determinations have been made of the temperatures in going fires, but he believes that in most soils, when reasonably moist, these would seldom exceed 30° C. No studies have been made of light or of available soil moisture.

Other problems that have been studied by the Department include the significance of tree races and tree heredity from a forestry point of view; the march of tree growth during the vegetative season; the classification of forest types from the botanical standpoint; the influence of root competition on reproduction and growth; tree phenology; and forest pathology. Comparatively little attention has been paid to the latter field, however, partly because tree diseases do not appear to be particularly serious in Sweden and partly because their control is regarded as rather hopeless. The entire vegetation is used as a basis for classifying forest types for silvicultural purposes, but it is not believed that this can be relied upon, as it is in Finland, to

indicate the site class occupied by any particular stand.

The Department of Forest Entomology is investigating the life history, habits, and methods of control of important forest insects. Prof. Trägårdh has approached the problem from the standpoint of the inter-relation between forests and insects, and of utilizing forest management as a means of control. He endeavors to determine why certain trees are attacked and others not, and is thus getting rather deeply involved in questions of physiology and chemistry. Studies are also being made of the abundant insect life found in forest soils, and its influence on soil formation and soil properties.

The Department for Regenerational Research in Norrland is concentrating its attention on determining the conditions under which coniferous seed ripens and germinates in the far north, measures for inducing natural reproduction, and the best methods of sowing and planting. The severe opening up of dense stands and the light burning of moss-covered areas are found to give beneficial results in many cases. Conditions are so different from any encountered in the United States that the results obtained are hardly applicable here.

Although the Forest Research Institute has its office and laboratory headquarters and an experimental nursery at Stockholm, its field work is carried on in all parts of Sweden. Permanent sample plots have been established wherever favorable conditions could be found, chiefly on state forests, but to some extent on private lands when freedom from interference was believed to be assured. Recently, however, the policy has been adopted of concentrating the work so far as possible at branch stations, the first of which was established in 1921.

These stations include an area of approximately 900 hectares

(about 2,250 acres) of forest land at Tönnersjöheden in southern Sweden; of 1,000 hectares (about 2,500 acres) at Siljanfors in central Sweden; and of 1920 hectares (about 3,800 acres) at Balbäcksliden and Svariberget in northern Sweden. The first and third are owned by the State, while the second has been turned over to the Institute without charge for a period of 50 years by a mining company with large timberland holdings (Store Kopparbergs Aktiebolag).

These forests are intended both for experimental use and to give the men at the Forest Research Institute actual experience in the management of a forest property. The latter idea is not, however, emphasized so strongly as in the much larger areas that have been turned over to the Forest Research Institute in Finland. Administration of the experimental forests is assigned to the Department of Forestry, but they are of course available for use by the other departments. All timber to be cut is marked by representatives of the Institute, which in addition to its experimental work aims to keep the areas in good silvicultural condition. The actual cutting, however, is handled by the State Forest Administration (Domstyrelsen) or the mining company, as the case may be.

Each area is in charge of a resident ranger (skogsmästare), who has been trained at a sort of superior ranger school known as a "continuation school". At Tönnersjöheden there is a field laboratory in connection with the ranger station. At Siljanfors the Institute rents a building from the mining company for the use of the ranger and his family, and retains 3 rooms, including a laboratory, for the use of visiting forest officers. At Balbäcksliden the Institute has erected in the heart of the experimental area a building with a large laboratory,

dark room, dining room, kitchen, three bed rooms, and a servant's room. In addition it has built a station at the neighboring town of Vindeln for the year-long use of the ranger in charge, 3 rooms in which are reserved for the use of visitors. There are thus at each branch station adequate field headquarters which are used by the men at the Institute for weeks at a time and are regarded by them as essential for the most effective use of the areas.

When experiments are established on the State forests it is often possible to obtain the assistance of the local rangers in protecting them and in maintaining current records by paying an additional salary of from 25 to 50 cents a day. These men are usually very reliable, consider it an honor to be so employed, and often become keenly interested in the work.

The Forest Research Institute has a fine library and excellent laboratory facilities. The results of its activities are published in 4 forms, - "Heddelanien från Statens skogsförsöksanstalt", which contains detailed accounts of its scientific investigations; "Skogliga Rön", which contains shorter and more popular accounts of these investigations; "Flygbild", which contains brief items and notices of various sorts; and "Exkursionsledare", which contains descriptions of the experimental forests and other experimental areas, and of the investigations being conducted there. Articles by members of the staff also appear in other periodicals.

Considerable research is done by professors at the Forest High School, for instance Tor Jonson, who has gone further in forest mensuration than the men at the Institute, and also by other individuals both in public and private employ. Investigations of this sort are

fostered by a foundation for the promotion of forest research (Fonden för Skogsvetenskaplig Forskning), which was established about the close of the war at the initiative of the Board of Administration of the Forest Research Institute. Funds were donated by private individuals, companies, and associations, and now amount to some 350,000 Kr. (about \$34,000). The interest on this capital, which is now increasing very slowly because of unfavorable economic conditions, is used to subsidize research which would not otherwise be undertaken. Government institutions are ineligible to receive grants, which go mostly to foresters in private employ.

Forest research in Sweden is of particular interest because of its extent, its high quality, and the fact that forest and economic conditions are somewhat similar to those in parts of the United States. The branch station organization also corresponds very closely to that in this country. The activities of the Department of Natural Science at the Institute and of Prof. Jonson at the School are perhaps of special interest to American foresters and ecologists; and that of Prof. Trägårdh to entomologists. Close contacts with the work are well worth cultivating.

CONCLUSION

The outstanding impression of my visits to European forest experiment stations is that forest research in the United States compares very favorably on the whole with that in Europe.

From the standpoint of organization, I believe that we have the more effective system. Irrespective of the theoretical authority of the director of the station or of the next higher official to whom he reports, the prevailing practice in Europe is to give each department or individual in the station practically a free rein and to minimize the importance of supervision. Very likely this is due to a healthy reaction against the bureaucracy which ordinarily exists in the administrative end of the work and which would seriously detract from the enthusiasm, initiative, and originality of the true investigator. Whatever the cause, I feel that the pendulum has swung so far in the direction of individual liberty as to prevent the most effective correlation of effort by those working on allied problems.

In spite of the brilliant work that is being done among European forest investigators, I cannot escape the conviction that this would count for still more if it were a more integral part of a comprehensive and coordinated program, and if it were more closely connected with the work of their colleagues. It is becoming more and more clear that the sharp distinctions which we have been accustomed to make between the various fields of forestry do not exist in fact, but that there is an overlapping of fields which must be taken into consideration in the solution of almost any forest problem. This being the case, it seems evident that the most rapid progress will be made

by a well-knit group of investigators working in close cooperation on a common program.

Real correlation of effort on problems of major importance obviously requires real supervision both in the preparation and in the execution of plans, which should, however, be accompanied by the equally necessary freedom from bureaucratic restraint on the individual in carrying out his share of the program. At present I believe that the experiment station organization in the United States more nearly approaches this ideal than is generally the case in Europe. It is, however, important to note the danger, which the Europeans are trying so hard to avoid, of emphasising supervision and coordination to the extent of killing individual initiative.

Except in Germany, there is the same attitude as here in regard to the importance of keeping the forest experiment stations separate from the educational and administrative organizations. Our policy of concentrating the work so far as possible at strategically located branch stations is also being rather generally adopted.

The work of the European forest experiment stations is usually followed with keen interest both by the administrative force in the state service and by private foresters. In Sweden and Finland especially this interest is stimulated and results are demonstrated by organized excursions to experimental areas, and particularly to the branch stations, which are proving of great educational value. Possibly we could go farther in this direction than we are now doing. I believe that we are ahead of the Europeans, however, in obtaining the cooperation of the administrative men in the preparation of our investigative programs and thus in getting their judgment as to the problems most urgently in need of study.

With respect to personnel, the European investigators average somewhat older than those in this country, and many of them are probably better known internationally. I doubt, however, whether there is much difference in native ability. The chief advantage of the Europeans, aside from age and experience, lies in the fact that so many of the men at the experiment stations have had thorough training in the underlying sciences, such as botany, zoology, chemistry, and physics. This gives them an advantage in getting really to the bottom of difficult problems which it is hard to over-estimate. On the other hand those without some training in forestry are apt to find themselves rather handicapped in getting a proper orientation and in the interpretation and application of their findings. It seems to be the consensus of opinion in Europe that men with a combined training in forestry and in the basic sciences are the most effective workers. This is particularly true in view of the growing tendency toward fundamental work. I believe that the most important lesson which Europe has to teach us in personnel is the need for more men of this type at our own stations.

Except in Austria there seem to be no concrete plans for the training of research personnel, but every effort is made to obtain the best possible men. The Austrian proposal to provide men opportunity for such advanced study as may be necessary to fit them most fully for their particular job has of course been favorably considered here, but is not practicable under existing law.

As to actual research, I believe that the European stations have most to teach us in forest ecology and forest soils. Their work in these fields is of particular interest because it is being handled

largely by men with thorough training in the physical and biological sciences. This gives them a background and a technique which we too often lack. The classification of forest types on an ecological basis, the significance of the herbaceous and shrubby vegetation, methods of determining the physical, chemical, and biological properties of forest soils, and the inter-relation between these properties and tree growth, are all questions on which we can learn much from European investigators.

Forest soils are being studied from a wide number of angles at the various stations, but particular emphasis is perhaps being laid on nitrogen, acidity, moisture, and aeration. Nitrogen is generally determined in the form of total nitrogen, nitrate nitrogen, and ammonia nitrogen, the usual chemical methods being used for the purpose. Acidity is commonly determined by the electrical method, altho the colorimetric method is still used to some extent, particularly for field determinations. Moisture content is determined in per cent of total dry weight by oven-drying. Aeration, in Czechoslovakia at least, is determined by finding the amount of air still retained in the soil after saturation with water (for details of the method see H. Burger, Mitt. Schweiz. Centralanstalt forstl. Versuchswesen, t. 13, 1932, p. 1-221). Hesselman found that for the soils with which he was dealing, and particularly the more acid ones, very little change in properties took place for a month or more after the collection of the samples, which were stored in clean linen sacks as far as possible at the same moisture content as in nature. Comparatively little is being done in studies of the actual availability of either soil moisture or nitrogen. Light is at present receiving scant attention.

With specific reference to the influence of environmental

factors on natural reproduction and growth, the work to date indicates both the importance and the complexity of the problem. Empirical studies permit of rather broad generalizations, but really intensive silviculture requires a knowledge of the reasons underlying the results secured. It is, however, no easy task either to measure the many factors involved in terms of their true influence on tree growth, or to determine the relative importance of each. The efforts of European forest investigators to solve these difficulties are pretty well summed up, both as to technique developed and results so far obtained, in the publications of Henselman, Hamee, Aaltonen, and Cajander. Their experience emphasizes the need of correlated effort by men with thorough scientific training and the forestry point of view. It also emphasizes the need of further critical study of the entire vegetative cover on actual or potential forest lands as an expression of the net influence of all the physical factors concerned, and consequently as an indication both of their productive capacity and of the silvicultural treatment to which they are best adapted.

In forest mensuration, Sweden is doing particularly interesting work in studies of tree form, Finland in the preparation of yield tables, and both countries in the strip method of estimating large areas and in the use of statistical methods in forestry. A careful study of the estimating methods used by these countries would be well worth while before any comprehensive timber survey is undertaken here. Studies of thinnings are nearly everywhere carried on by the sample plot methods that are usual with us.

Silvicultural investigations of methods of cutting and of the best methods of sowing and planting are usually made by methods

with which we are already familiar. Much more has been done than with us in studying the influence of source of seed. The results are sufficiently striking to emphasize the importance of more work in this direction over here.

Forest entomology is receiving much attention at a number of stations, with the most interesting work probably under way in Sweden. Forest pathology appears to be rather neglected by the experiment stations; perhaps more is being done at the forest schools and universities.

In forest products research the United States is far in the lead. Economic investigations in Europe are still in their infancy, as is the case here, but definite plans for their expansion are being formulated in Finland and Czechoslovakia.

Taking everything into consideration, I should rate the stations visited in order of interest to American foresters as follows: Sweden, Finland, Saxony (Tharandt), Czechoslovakia, Austria, and Italy. As to individuals, I believe that the following have the most to contribute in the fields indicated:

Forest Soils, - Hesselman (Stockholm), Hamec (Prague), Kvapil (Prague), Aaltonen (Helsinki), Krauss (Tharandt), Wiedemann (Tharandt), and Rumov (Mariabrunn). (Parenthetically I might add that Dr. Oscar Hagen, Director of the West Coast Forest Experiment Station, Bergen, Norway, whom I did not meet, is said to be doing some excellent work on the relation of the nitrogen content of forest soils to the bacteria present).

Forest Types and Forest Botany, - Cajander (Helsinki), Hesselman (Stockholm), and Münch (Tharandt).

Forest Menaximation, - Ilvessalo (Helsinki), Jonsson (Stockholm),

and Petrini (Stockholm). Busse (Tharandt), Haas (Brno), and Schmid (Mariabrunn) would come in a second and less important group.

Silviculture, - Wiedmann (Tharandt), Pettersson (Stockholm), Tschernak (Mariabrunn), and Heikinheimo (Helsinki).

Forest Entomology, - Trägårdh (Stockholm), Prell (Tharandt), Komarek (Prague), and Sedlacek (Mariabrunn).

Finally, I believe that the closest possible contact with European forest experiment stations will prove of great value in the development of forest research in this country. This is not so much because of any innate superiority on their part, as because of the stimulus and guidance to be had from knowing definitely the methods being used and the results being obtained by other investigators in the same field. Fundamentally European and American forest problems do not differ greatly; and the fact that the European point of view and method of attack are often different from ours, instead of being a drawback, may be a real help in throwing light on the problem from a new angle.

Contacts can be maintained by exchanging and reviewing periodicals and other publications, by correspondence, and by occasional visits from European foresters to America and from American foresters to Europe. When such visits are for the study of some specific institution or problem, too much travel should be avoided, and sufficient time spent at one or a few places to cover the ground thoroughly. Things move more slowly in Europe than here, and more time will nearly always be required than is originally anticipated. Europeans, particularly perhaps at the forest experiment stations, are taking a constantly increasing interest in American forestry, which they are anxious to see for themselves, and are nearly always glad to welcome American visitors.

The International Union of Forest Experiment Stations offers one of the most promising means of keeping forest investigators throughout the world in touch with each other, particularly if it can get sufficient funds to maintain a permanent organization. I hope that the Forest Service can be well represented at its 1929 meeting in Sweden.

July 15, 1927